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Descriptions and Preliminary Report on Sediment Cores from the Southwest Coastal Area, Everglades National Park, Florida

U.S. Geological Survey Open File Report 2005-1360

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ABSTRACT

Sediment cores were collected from five locations in the southwest coastal area of Everglades National Park, Florida, in May 2004 for the purpose of determining the ecosystem history of the area and the impacts of changes in flow through the Shark River Slough. An understanding of natural cycles of change prior to significant human disturbance allows land managers to set realistic performance measures and targets for salinity and other water quality and quantity quality measures. Preliminary examination of the cores indicates significant changes have taken place over the last 1000-2000 years. The cores collected from the inner bays – the most landward bays – are distinctly different from other estuarine sediment cores examined in Florida Bay and Biscayne Bay. Peats in the inner-bay cores from Big Lostmans Bay, Broad River Bay, and Tarpon Bay were deposited at least 1000 years before present (BP) based on radiocarbon analyses. The peats are overlain by poorly sorted organic muds and sands containing species indicative of deposition in a freshwater to very low salinity environment. The Alligator Bay core, the most northern inner-bay core, is almost entirely sand; no detailed faunal analyses or radiometric dating has been completed on this core. The Roberts River core, taken from the mouth of the River where it empties into Whitewater Bay, is lithologically and faunally similar to previously examined cores from Biscayne and Florida Bays; however, the basal unit was deposited ~ 2000 years before the present based on radiocarbon analyses. A definite trend of increasing salinity over time is seen in the Roberts River core, from sediments representing a terrestrially dominated freshwater environment at the bottom of the core to those representing an estuarine environment with a strong freshwater influence at the top. The changes seen at Roberts River could represent a combination of factors including rising sea-level and changes in freshwater supply, but the timing and extent of the changes needs to be determined. The preliminary information on the cores collected in 2004 will be combined with data from cores collected in July 2005. The 2005 cores were collected along transects moving from the inner bays out towards the coast. These transects, combining information from the 2004 and 2005 cores, will allow us to examine long term trends in freshwater supply, sea-level rise, and potentially the impact of storms on the coastal ecosystem.

INTRODUCTION

Currently, south Florida is undergoing a massive restoration effort guided by the Comprehensive Everglades Restoration Plan (CERP). One of the primary goals of the CERP is to restore the natural flow of water through the terrestrial Everglades and into the coastal zones. Historically, Shark River Slough, which flows through the central portion of the Everglades southwestward, was the primary flow path through the Everglades Ecosystem. This natural movement of water, however, has been dramatically reduced over the last century as construction of canals, water conservation areas and the Tamiami Trail either retained or diverted flow (Light and Dineen, 1994). The reduction in flow and changes in water quality through Shark River have had a significant effect on the freshwater marshes and the associated coastal ecosystems. Additionally, the flow reduction may have shifted the balance of fresh to salt-water inflow along coastal zones, resulting in an acceleration of the rate of inland migration of mangroves into the freshwater marshes.

Both the CERP and the Department of Interior Science Plan identify the importance of understanding freshwater flow into south Florida's estuaries, and the changes incurred in the estuaries due to anthropogenic alterations of freshwater flow. One of the three primary objectives stated in the DOI Science Plan is to "ensure that hydrologic performance targets accurately reflect the natural predrainage hydrology and ecology" (DOI Science Plan, 2004, p. 14). A historical perspective can be obtained by examining the record of the hydrologic and biologic components of the natural system preserved in the sediments of south Florida. This method has been successfully utilized by USGS researchers in Florida Bay and Biscayne Bay since 1995 (Brewster-Wingard and others, 2001; Ishman and others, 1998; Wingard and others, 2003, 2004) and has provided a general picture of changes that have occurred to the system. These data have been used by CERP teams (Florida Bay Florida Keys Feasibility Study and the Biscayne Bay Coastal Wetlands), and the Southern Estuaries sub-team of Restoration, Coordination, and Verification (RECOVER), to begin the process of setting salinity targets and performance measures for the estuaries.

In 2004, the USGS Ecosystem History of South Florida's Estuaries Project shifted research emphasis towards the southwest coastal area. The objectives of this research are to document impacts of changes in salinity, water quality, coastal plant and invertebrate communities and other critical ecosystem parameters on a decadal to centennial scale in the southwest coastal region (from Whitewater Bay, north to the Ten Thousand Islands), and to correlate these changes with natural events and resource management practices. Examination of these long-term (centennial scale) data sets will allow us to determine what the natural trends or cycles of change (such as rising sea-level or changes in climatic patterns) within the ecosystem were, and how anthropogenic alteration offset those natural cycles. By projecting the natural trends of the 19th century forward through the 21st century, we can estimate the unaltered natural conditions of the ecosystem. These forecast values can be used as targets for restoration, because the real aim of performance measures or targets should be to bring the ecosystem back in line with the natural patterns representative of an unaltered system.

Setting

The southwest coastal area is the downstream recipient of water flowing through the Shark River Slough, and is adjacent to cypress and marl prairie ecotones. The region is a complex network of channels, bays, coastal prairies, and mangroves (Figure 1). A northwest-southeast trending line of inner bays marks the transition between the coastal and terrestrial ecosystems; the Everglades National Park Wilderness Waterway follows these inter-connected bays. Four of the five cores (Alligator Bay (AB), Big Lostmans Bay (LM), Broad River Bay (BR), Tarpon Bay (TB)) were collected from these inner bays in order to understand the historical conditions and range of variability of this zone. Currently, this system is exposed to significant variability. Between 1995 and 2004, salinities in these bays have ranged from <1 ppt to > 30 ppt , with averages in the 4-7 ppt range (data summarized from http://www.sfwmd.gov /org/ema/envmon/wqm/wqprojects.html, accessed March, 2005; Table 1). A general trend of decreasing average salinity values can be seen moving from Alligator Bay southeast to Tarpon Bay, which may reflect the increasing influence of the Shark River Slough outflow. Preliminary, observations of the molluscan fauna indicate relatively low diversity and abundance in these transitional areas. The fifth core was collected from near the mouth of Roberts River (RR), where it empties into Whitewater Bay. Salinities near this site range from <1 ppt to 30 ppt, with an average of 8 ppt over the period from 1995-2005 (Table 1) and preliminary examinations of the molluscan faunal assemblages indicate similarities to analogous sites in Florida Bay.

Acknowledgements

We would like to thank Everglades National Park for their cooperation in this study; the work described here was conducted under Study #EVER-00141 and permit #EVER-2003-SCI-0053. This work was funded by the U.S. Geological Survey (USGS) Priority Ecosystems South Florida Study Unit. Rob Stamm and Marci Marot, USGS, assisted in the core collection; and Marci Marot supervised the core cutting process. Jim Murray, USGS, assisted in the processing of the cores. Joel Hudley, USGS, assisted in the preparation of the figures. Radiometric carbon analyses were conducted by Beta Analytic Inc. (Miami, FL). We would like to thank our reviewers Bruce Wardlaw, Bill Orem, and Joel Hudley (USGS) for their thoughtful and thorough reviews of the manuscript.

METHODS

Ten piston cores were collected from five sites in Everglades National Park on May 4-5, 2004 (Table 2; Figures 1 and 2) under ENP Permit # EVER-2003-SCI-0053. Duplicate cores, A and B, were taken side by side at each site (10-20 cm apart). X-radiographs of the A cores were made, and the upper 10 cm of each A core were cut vertically into 1-cm

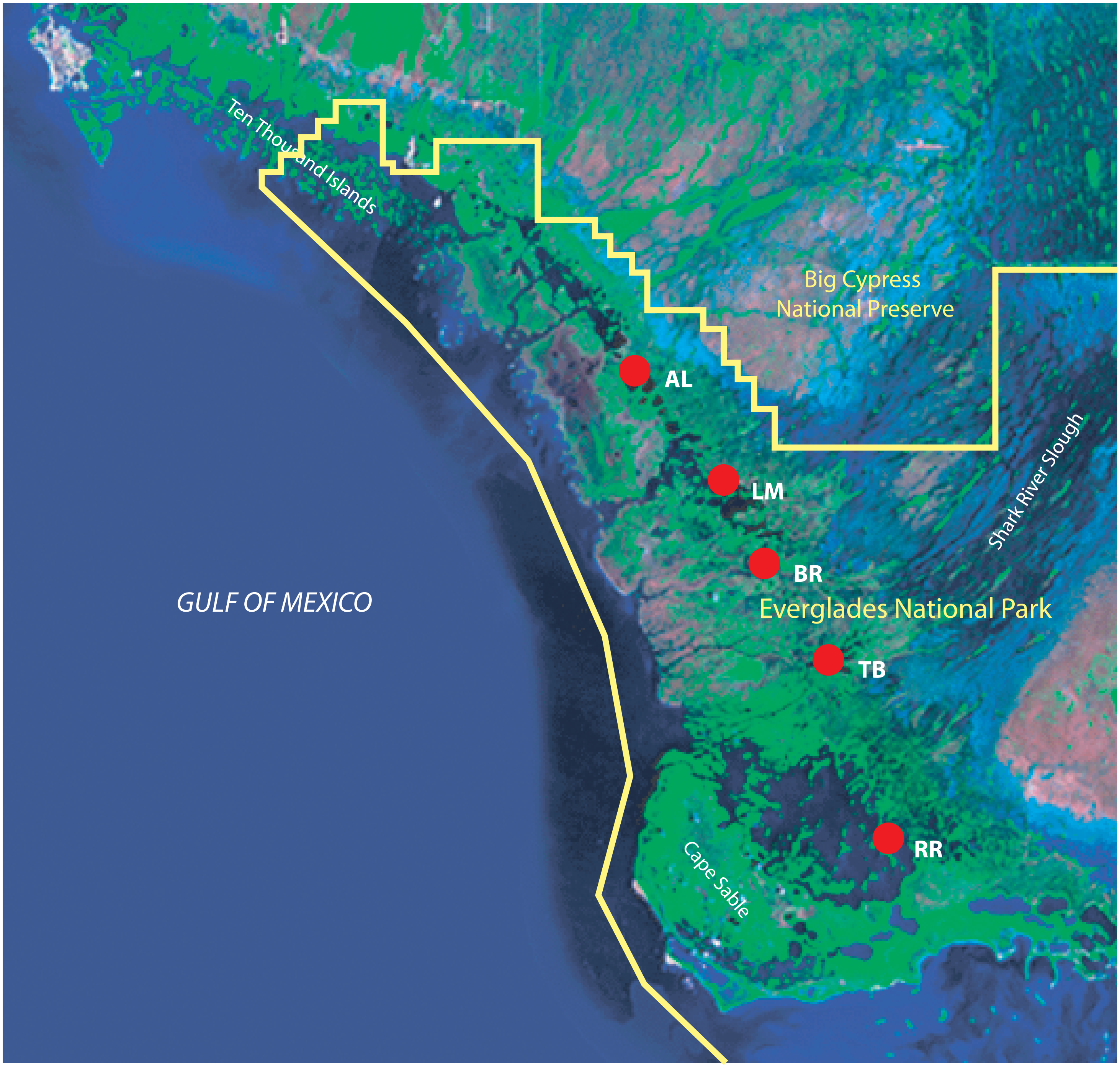


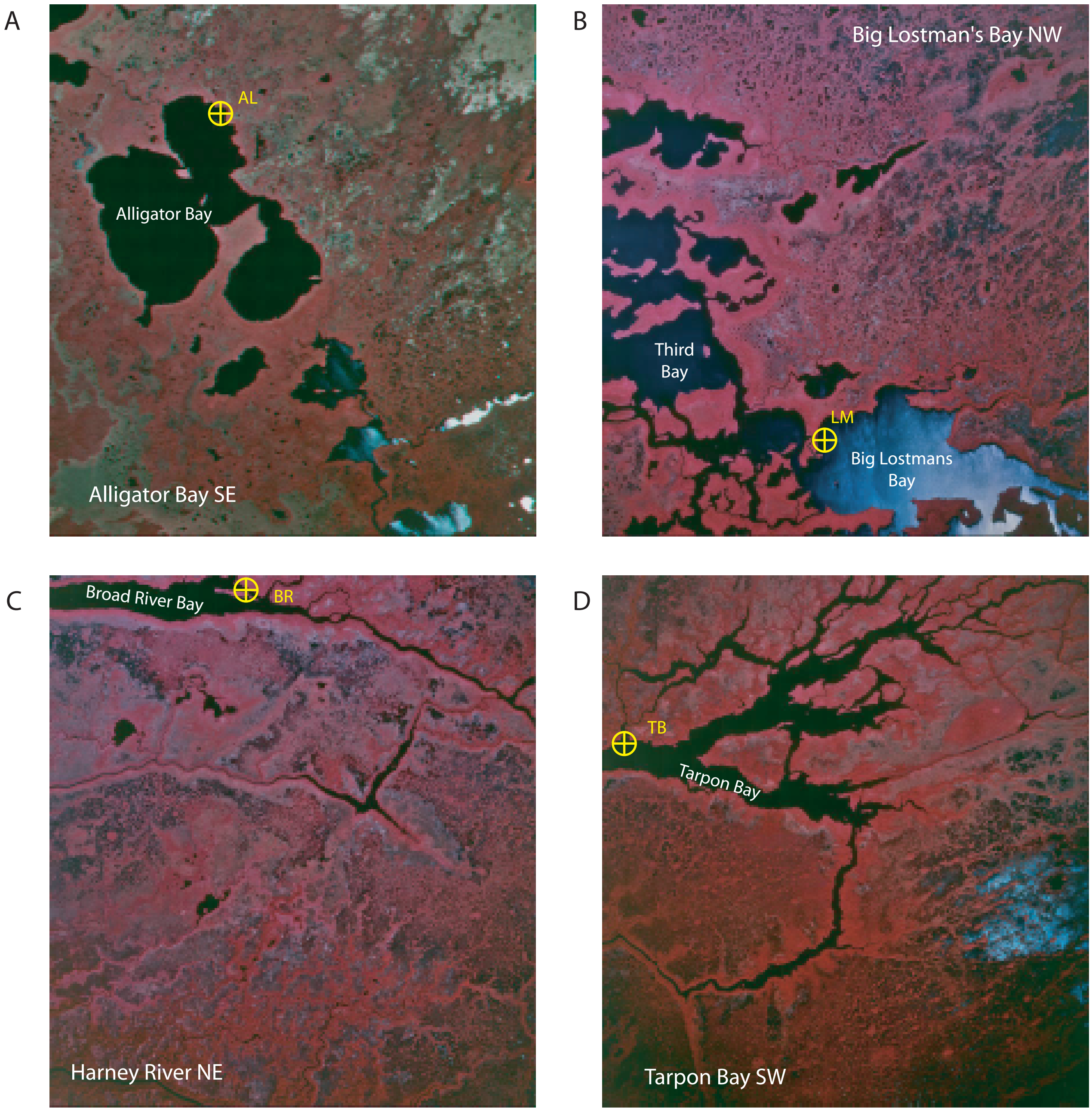
Figure 1. Satellite image of the southwest coast of Florida, showing general location of cores. Yellow line marks approximate boundary of Everglades National Park. Red dots indicate location of May 2004 core sites; AL=Alligator Bay Core; LM=Big Lostmans Bay Core; BR=Broad River Bay Core; TB=Tarpon Bay Core; and RR=Roberts River Core from river mouth. Image cropped from John W. Jones and others (2001). Table 1 gives geographic coordinates of core locations and Figure 2 illustrates precise location of cores.

Table 1: Summary of salinity data for 1995-2004 from bays where cores are located. Data from South Florida Water Management District's Water Quality Monitoring Project (Data from http://www.sfwmd.gov/org/ema/envmon/wqm/wqprojects.html, accessed March, 2005). Note: Data were collected approximately once/month, and generally two measurements were taken for each collection.

Station ID	**Station Location**	**Latitude**	**Longitude**	**Number of salinity measurements**	**Time frame of data collection**	**Average ppt**	**Standard Deviation**	**Minimum ppt**	**Maximum ppt**
TTI62	Alligator Bay	254013	811007	188	7/1996 to 6/2004	7.3	7.531	0.1	35.2
FLAB31	Big Lostmans Bay	253403	810417	236	1/1995 to 6/2004	7.0	9.399	0	35.4
FLAB33	Broad River Bay	252959	810256	231	1/1995 to 6/2004	5.2	7.218	0.1	29.6
FLAB38	Tarpon Bay	252502	805954	235	1/1995 to 6/2004	4.5	6.349	0.1	30.4
FLAB47	Mouth of Roberts River	251647	805551	237	1/1995 to 6/2004	7.9	7.161	0.3	29.6

Table 2: List of cores collected in May 2004 in the southwest coastal area of Everglades National Park, Florida. See Figure 1 for general location of all cores and Figure 2 for more precise location of each core.

Core Location	Date Collected	Core ID	Latitude	Longitude	Water Depth (cm) at Collection	Initial Core Length (cm)	Core Length when cut (cm)	Loss or gain during drying and cutting (cm)
Alligator Bay	5/4/2004	GLW504-ALA	N 25° 40.55	W 81° 09.94	120	74.0	60.0	-14
		GLW504-ALB				65.5	Not cut	
Big Lostmans Bay	5/4/2004	GLW504-LMA	N 25° 34.02	W 81° 05.86	75	61.5	58.0	-3.5
		GLW504-LMB				55.5	Not cut	
Broad River Bay	5/4/2004	GLW504-BRA	N 25° 30.14	W 81° 02.31	75	129.0	133.0	+ 4.0
		GLW504-BRB				99.0	Not cut	
Roberts River, mouth	5/5/2004	GLW504-RRA	N 25° 16.21	W 80° 55.69	25	98.5	88.0	-10.5
		GLW504-RRB				93.0	Not cut	
Tarpon Bay	5/5/2004	GLW504-TBA	N 25° 25.23	W 80° 59.95	75	108.0	95.0	-13.0
		GLW504-TBB				80.0	Not cut	



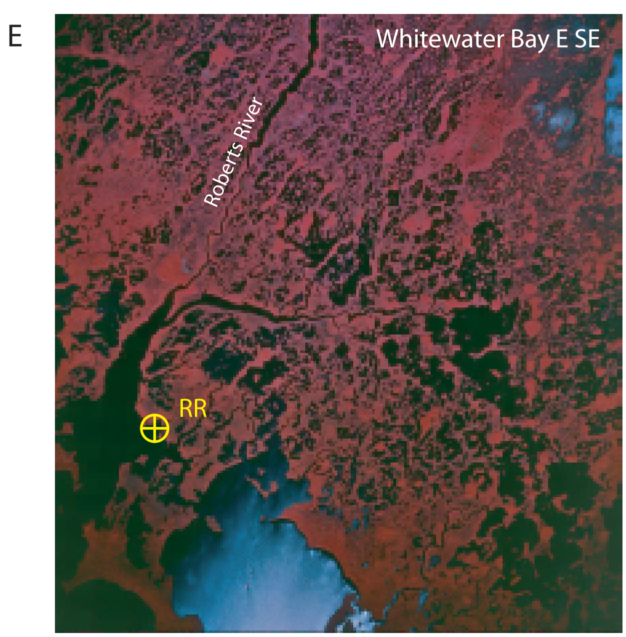


Figure 2. Digital Orthophoto Quadrangles (DOQs) of core locations, arranged in order from northwest to southeast. A. AL=Alligator Bay core plotted on Alligator Bay SE DOQ. B. LM=Big Lostmans Bay Core plotted on Big Lostman's Bay NW DOQ. C. BR=Broad River Bay Core plotted on Harney River NE DOQ. D. TB=Tarpon Bay Core plotted on Tarpon Bay SW DOQ. E. RR=Roberts River Core from mouth of River plotted on Whitewater Bay east SE DOQ. All images obtained from http://edcsns17.cr.usgs.gov/EarthExplorer/

segments for analyses; below 10 cm the samples were cut into 2-cm segments. The subset A cores are currently undergoing analysis for faunal remains (ostracodes, foraminifers and mollusks) and where possible for pollen, lead-210 dating, and sedimentary and shell geochemistry. Due to the high quantity of peats in many of these cores, in some cases the B cores will be utilized for pollen, lead-210, and sediment geochemistry analyses. Portions of the subset B cores will be archived for future additional analyses.

Processing of ostracodes, mollusks, foraminifers, and pollen is following the procedures described in Cronin and others (2001), Brewster-Wingard and others (2001), Ishman and others (1998), and Willard and others (2001). Mollusks in the >850 micron size fraction were picked from processed samples for four of the five cores (BR, LM, RR, TB), and sorted taxonomically. For the purposes of this report, samples were scanned and presence or absence of key environmental and/or salinity-indicator molluscan species were noted (Table 3), but absolute and relative abundance have not yet been calculated. The Alligator Bay core (AL) has not been processed; the molluscan specimens listed in Table 3 were pulled from the samples during the description process; therefore the taxonomic list is biased towards the larger specimens. Ostracodes between 63 and 850 microns were examined from Broad River Bay and Roberts River cores.

Developing the age model for the cores involves three methods: 1) accelerator mass spectrometry (AMS) radiocarbon analyses of shell or wood material; 2) lead-210 analyses of the sediments; and 3) palynological analyses. The first occurrence of exotic species of pollen, when present, can be used as stratigraphic markers if the time of introduction is known. For example, *Casuarina* (Australian pine) was introduced into south Florida around 1900 (Langeland, 1990). Due to the remoteness of the southwest coastal area, exotic pollen may not be present, but patterns of change in pollen assemblages can be correlated across south Florida, providing a frame of reference for interpreting the radioisotopic analyses. As the first step in determining an age model for the 2004 cores, wood fragments and plant materials were analyzed for carbon-14 (Table 4). The AMS radiocarbon analyses were conducted by Beta Analytic Inc. (Miami, FL). Pre-treatment of samples used acid/alkali/acid protocol (Beta Analytic Inc., http://www.radiocarbon.com/ pretreatment.htm, last accessed 9/8/2005). The radiocarbon dates were calibrated using the procedure in Talma and Vogel (1993) and the INTCAL98 calibration dataset (Stuiver and others, 1998). Radioisotopic analyses of lead-210 and pollen assemblage analyses are in progress for the cores.

LITHOLOGIC DESCRIPTION OF CORES

Sediment core descriptions were based on examination of core samples under a binocular microscope in a laboratory setting. Grain size is based on the Wentworth classification. Sediment color is based on the Munsell Rock Color Chart and was made on wet sediments (or damp in the case of Alligator Bay core). The following descriptions are arranged in a northwest to southeast transect (see Figure 1 for general location).

Table 3. Presence (P) of mollusks that serve as key salinity and/or environmental indicators is shown on table. Note: this list does not represent all mollusks present in the samples.
Also, the Alligator Bay core was not processed; mollusks were pulled from the samples during description, and are therefore biased towards the larger taxa.
"No calcareous remains" means no obvious molluscan shell material present. Closer examination of samples may indicate some minor occurrences of mollusks.

		Examined but no identifications	Terrestrial Mollusks	Freshwater Mollusks		Estuarine Mollusks							
				Minute - easily "rafted" on freshwater currents	Adult stages large	Very low salinity (0-12 ppt)	Common in Mesohaline (5-18 ppt)		Euryhaline - Tolerant of wide range of salinities but common in transition zones between fresh and estuarine waters in south Florida				
Core	Depth (in cm)		Polygyridae and/or Pupillidae	Hydrobiid-like	Physidae, Lymnaeidae, *Planorbella*, *Elimia*- like	*Cyrenoida*, *Polymesoda*	*Tagelus*	Ostreids	Mytilids	*Anomalocardia*	*Cerithidea*	Tellinidae	*Acteocina*
Alligator Bay (GLW504-ALA)													
	0-2				P								
	2-4					P							
	4-6				P	P				P			
	6-8				P		P						
	8-60	No calcareous remains											
Broad River Bay (GLW504-BRA)													
	0-2			P		P							
	2-4					P							
	4-112	No calcareous remains											
	112-114				P								
	114-116		P		P								
	116-118		P	P	P								
	118-120		P		P								
	120-122		P		P								
	122-124		P	P	P								
	124-126		P		P								
	126-128		P		P								
	128-130		P		P								
	130-133	No calcareous remains											
Big Lostmans Bay (GLW504-LMA)													
	0-2			P		P		P (worn)	P				
	2-4			P	P	P (worn)		P (worn)	P				
	4-6					P (worn)		P (worn)	P (worn)				
	6-8	Worn fragments											
	8-10												
	10-58	No calcareous remains											

Core	Depth (in cm)	Examined but no identifications	Terrestrial Mollusks	Freshwater Mollusks		Estuarine Mollusks							
				Minute - easily "rafted" on freshwater currents	Adult stages large	Very low salinity (0-12 ppt)	Common in Mesohaline (5-18 ppt)		Euryhaline - Tolerant of wide range of salinities but common in transition zones between fresh and estuarine waters in south Florida				
			Polygyridae and/or Pupillidae	Hydrobiid-like	Physidae, Lymnaeidae, *Planorbella*, *Elimia*- like	*Cyrenoida*, *Polymesoda*	*Tagelus*	Ostreids	Mytilids	*Anomalocardia*	*Cerithidea*	Tellinidae	*Acteocina*
Robert's River (GLW504-RRA)													
	0-2			P	P				P	P		P	P
	8-10			P	P	P			P	P			P
	16-18			P					P			P	
	24-26			P	P	P			P	P		P	
	32-34			P	P	P	P		P	P			P
	40-42			P	P	P			P	P	P	P	
	48-50			P	P	P (few)			P (few)				
	56-58			P	P	P (few)							
	64-66			P	P								
	72-74			P	P								
	80-82		P (few)	P	P								
	86-88		P	P	P								
Tarpon Bay (GLW504-TBA)													
	0-2			P	P	P							
	2-4			P	P	P	P	P	P				
	4-6			P	P	P		P	P			P	
	6-8			P	P	P						P	
	8-10			P		P		P	P				
	10-12			P	P	P			P				
	12-14			P	P	P			P				
	14-16			P	P	P			P				
	16-18			P	P	P			P				
	18-20			P		P			P				
	20-22			P		P			P				
	22-24			P		P			P				
	24-26			P		P			P				
	26-95	No calcareous remains											

Table 4. Results of AMS radiocarbon spectrometry analyses on samples from cores collected in 2004. Analyses were conducted by Beta Analytical Radiocarbon Dating Laboratory (Miami, FL). See methods section for a discussion of procedures.

Core ID	Depth (cm)	Beta ID	Sample Type>	Measured Radiocarbon Age (yrs BP)+	13C/12C ^ (0/00)	Conventional Radiocarbon Age (yrs BP)+	2 sigma calibrated age range (BP)+	Corrected Calendar Age#
GLW504-BR-A	24-26	206415	wood - mostly bark	220 +/- 40	-27.7	180 +/- 40	300-240; 230-70; 40-0	AD 1704-1764; AD 1774-1934; post-1950
GLW504-BR-A	50-52	206416	wood - mostly bark	2240 +/- 40	-27.1	2210 +/-40	2330-2120	BC 326-116
GLW504-LMA	20-22	206418	peat	1230 +/- 40	-25.3	1230 +/- 40	1260-1060	AD 744-944
GLW504-LMA	46-48	206419	peat	2430 +/- 40	-25.8	2420 +/-40	2710-2560; 2540-2350	BC 706-566; BC 536-346
GLW504-RR-A	82-84	206420	plant material	1970 +/- 40	-26.0	1950 +/- 40	1990-1820	AD 14-184
GLW504-TB-A	12-14	206421	wood (1 large piece)	290 +/- 40	-27.0	260 +/- 40	430-360; 330-280; 180-150; 10-0	AD 1574-1644; AD 1674-1724; AD 1824-1854; post-1950
GLW504-TB-A	42-44	206422	wood (twigs & bark)	1500 +/- 40	-27.9	1450 +/- 40	1410-1290	AD 594-714
GLW504-TB-A	50-52	206423	wood (1 large piece with bark)	1320 +/- 40	-28.6	1260 +/- 40	1280-1070	AD 724-934

> Samples were prepared by acid/alkali/acid pretreatment.

+ BP = Before Present (present for these calculations = 1950)

^ $^{13}C/^{12}C$ calculated relative to the PDB-1 international standar

* pMC = percent modern Carbon; analyzed material less than 50 years old

Corrected Calendar age converts 2 sigma calibrated age, where 1950 is used as "present", to 2004 - the year the cores were collected.

Alligator Bay Core (GLW504-ALA) (Figure 3)

Depth (cm)	**Description**
0-8	Muddy sand, sediments predominantly fine r to medium quartz sand, with some scattered coarse grains; relatively high mud content, increasing toward bottom of segment; mud content makes overall sample cohesive. Quartz grains mostly subangular to subrounded. Moderate to poorly sorted, with sorting decreasing toward bottom of segment. Scattered shells and calcareous grains. (Olive gray 5Y 3/2 to light olive gray 5Y 5/2)
8-30	Muddy sand, sediments range from very fine to coarse, subangular to subrounded quartz sand, with a large component of mud and silt present. Shells and calcareous grains are absent. Sorting decreases with depth and mud content increases. Small discrete clumps of black organic mud present in some samples. (Olive gray 5Y 3/2 to olive black 5Y 2/1)
30-60	Clayey sand, similar to overlying segment. Poorly sorted mix of very fine to coarse, subangular to subrounded quartz sand, but more clay than mud in this zone. Scattered plant material and possible root casts, and near bottom of segment, a few scattered calcareous grains. Sediments very mottled in appearance, especially in upper part of segment, in part due to drying of some zones forming slightly indurated clasts of sediment. Colors vary from light brownish gray (5YR 6/1) to olive gray (5Y 3/2), to olive black 5Y 2/1).

Big Lostmans Bay Core (GLW504-LMA) (Figure 4)

Depth (cm)	**Description**
0-10	Mud, organic, with relatively high water content, decreasing downward, and grading toward peat. Scattered calcareous grains (appear to be weathered marl in upper portion of segment), shell fragments, pieces of wood, and *Halodule* blades present. At 4-5 cm, *Halodule* oriented on bedding plane in bundles. Rare fine quartz grains. (Brownish black – 5YR 2/1 to black)
10-42	Peat, firm with no obvious quartz or calcareous grains. Macro-plant remains present throughout, primarily wood and stem pieces; some are parallel to bedding, others oriented vertically and maybe *in situ*. (Brownish black – 5YR 2/1 to black)
42-58	Sandy peat, poorly sorted, very fine to coarse angular to rounded quartz grains occur in pockets and thin layers within the peat matrix in upper

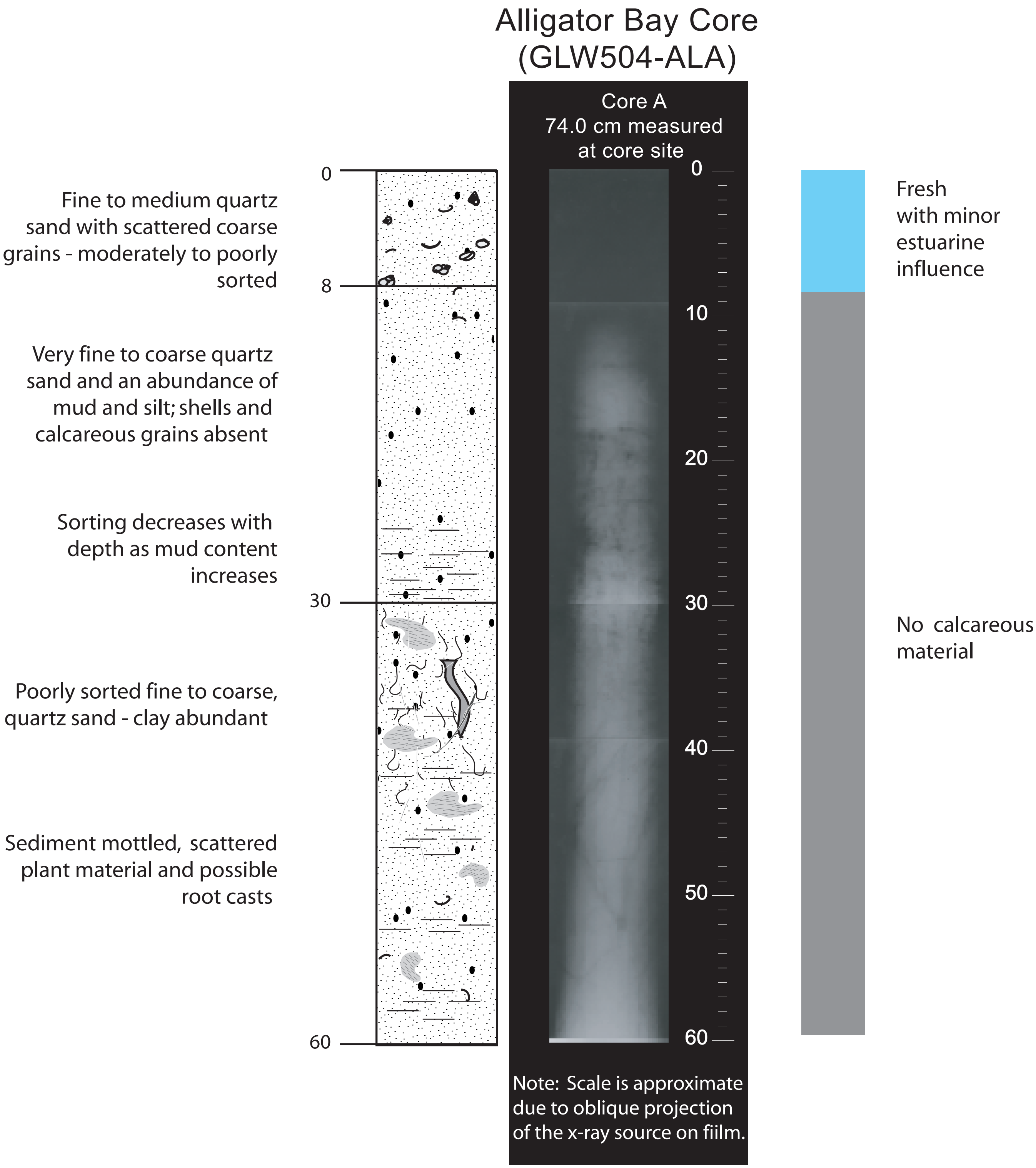


Figure 3. X-radiograph of Alligator Bay core (GLW504-ALA), with schematic diagram and brief sediment description on the left, and a summary of the environments indicated from an examination of molluscan fauna on the right. Note, "no calcareous material" means no visible grains; closer examination of samples may find additional material, especially microfaunal remains. Scale bar is in cm.

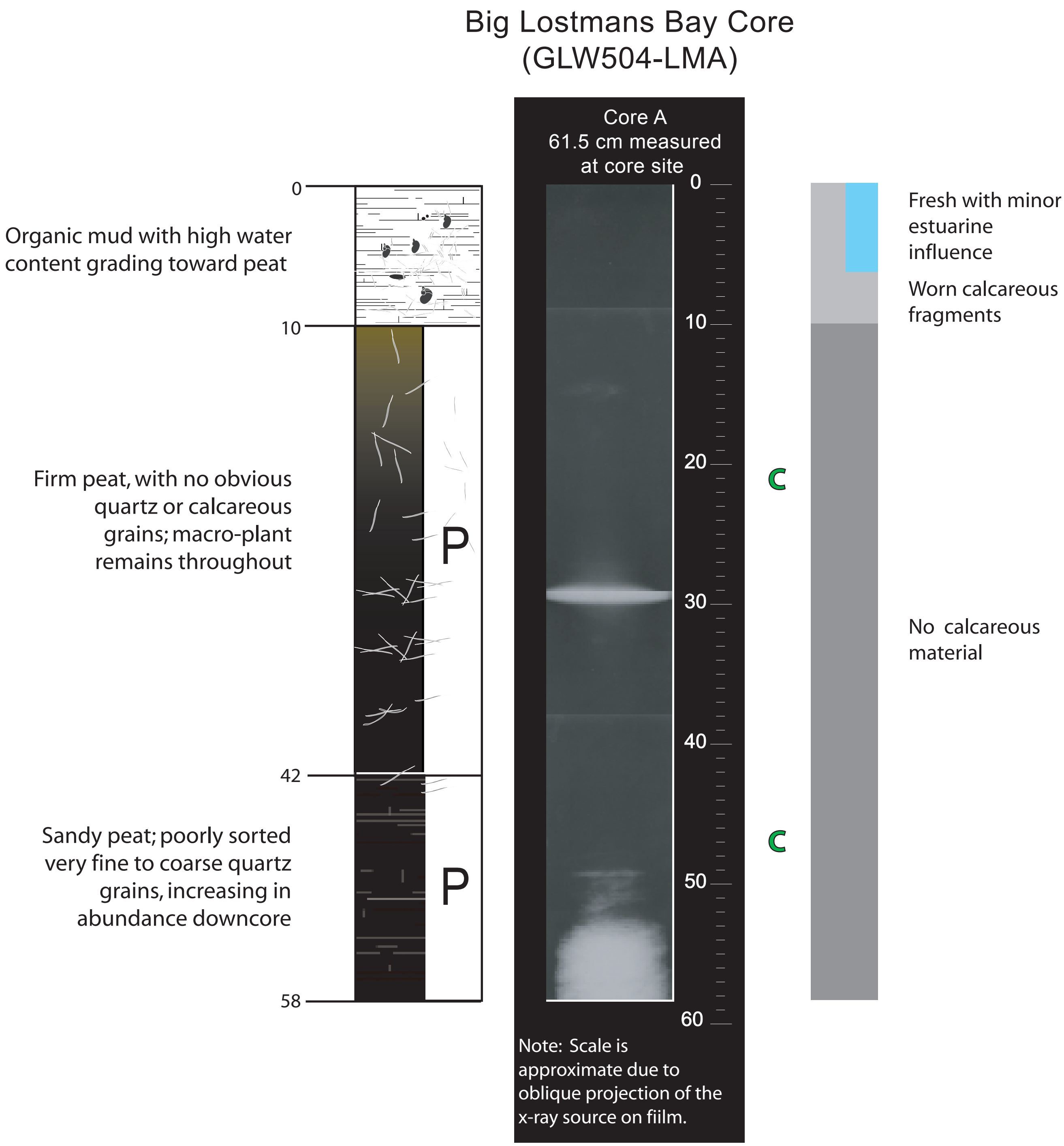


Figure 4. X-radiograph of Big Lostmans Bay core (GLW504-LMA), with schematic diagram and brief sediment description on the left, and a summary of the environments indicated from an examination of molluscan fauna on the right. Note, "no calcareous material" means no visible grains; closer examination of samples may find additional material, especially microfaunal remains. Location of carbon-14 samples is indicated by green "C". Scale bar is in cm.

portion of segment; sand gradually becoming more scattered, but increasing in abundance downcore. (Brownish black – 5YR 2/1 to black)

Broad River Bay Core (GLW504-BRA) (Figure 5)

Depth (cm)	**Description**
0-50	Sandy mud, sediments liquefied to very soft in upper ten centimeters (sample cannot hold cohesive shape); gradually becoming more cohesive with depth. Very fine sand to flocculated clays and/or organics with a few scattered medium to coarse, subangular quartz grains. Fibrous plant material, wood fragments, and leaves are common, with rare scattered calcareous grains (Olive black 5Y 2/1 to black)
50-112	Peat, spongy, fibrous, with fibrous plant material, wood fragments, and leaves visible. Water content decreasing downcore with compaction; becoming more cohesive. (Olive black 5Y 2/1 to black)
112-118	Peaty sandy mud, sediments transition between overlying peat (5Y 2/1) and a very fine grain sand to mud (pale yellowish brown - 10YR 6/2). Indication of either root casts or burrow; overlying peat extends down through this zone. Freshwater gastropods are relatively abundant in sample.
118-128	Sandy mud, segment fines upward. Matrix a firm clay/mud; getting darker with depth, ranging from pale yellowish brown to dusky yellowish brown (10YR 6/2 to 10YR 2/2). Increasing fibrous plant material toward bottom of segment, and an area (126-128 cm) with very fine sand disseminated through clay. Some freshwater gastropods present.
128-133	Peaty sand, gradational with overlying segment. Poorly sorted, sand ranging from fine to very coarse, subangular to rounded quartz grains, with abundant organic material dispersed throughout. (Olive black 5Y 2/1)

Tarpon Bay Core (GLW504-TBA) (Figure 6)

Depth (cm)	**Description**
0-20	Mud, cohesive, organic, with calcareous grains (including mollusks, foraminfers, and ostracodes) and scattered rare quartz grains. Fibrous plant material also present and occasional pieces of wood. Shell material relatively abundant in some zones of segment. (Brownish black – 5YR 2/1)

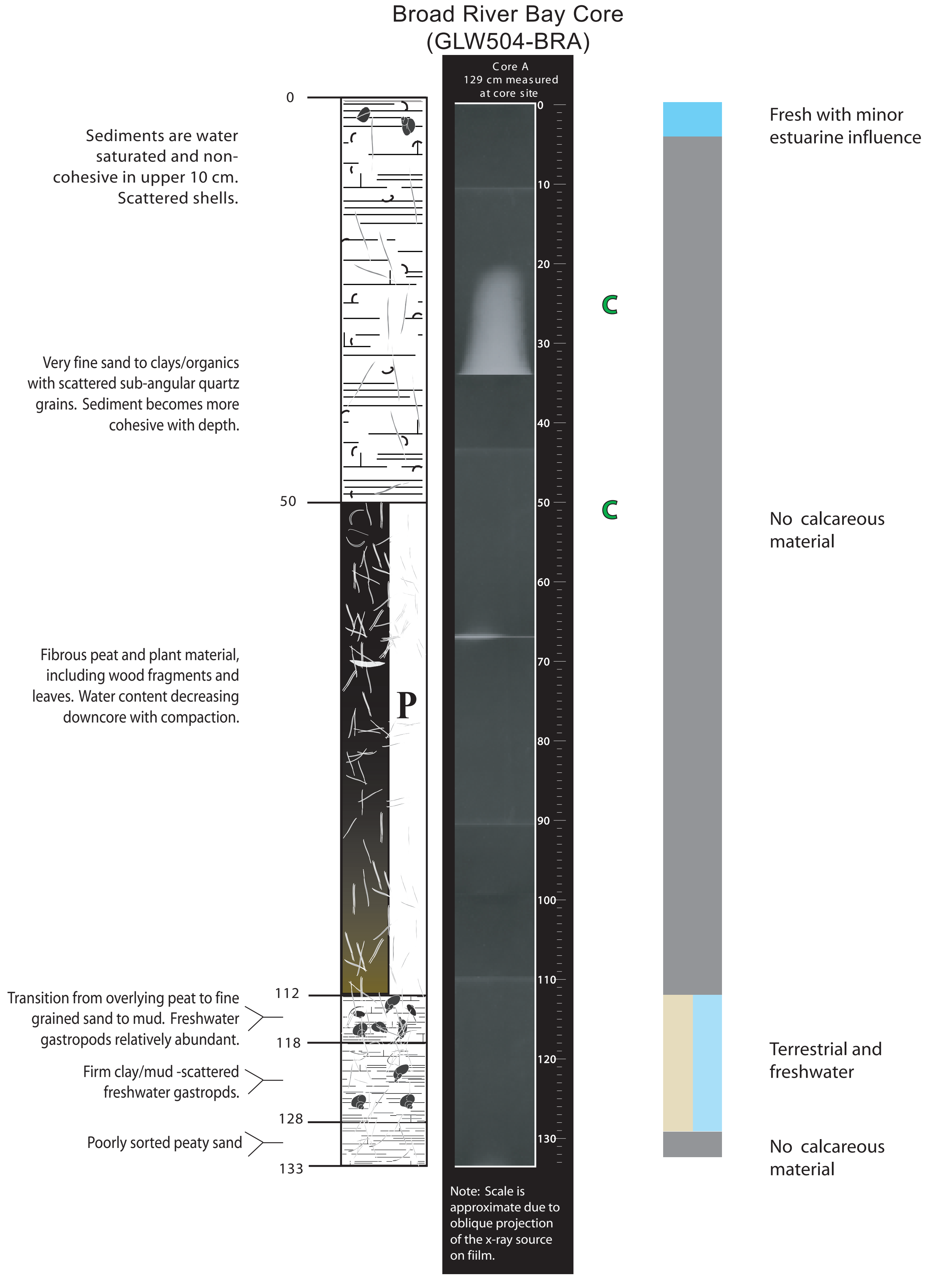


Figure 5. X-radiograph of Broad River Bay core (GLW504-BRA), with schematic diagram and brief sediment description on the left, and a summary of the environments indicated from an examination of molluscan fauna on the right. Note, "no calcareous material" means no visible grains; ostracodes and foraminfers have been recovered from the <63 micron fraction above 44 cm in the zone with no mollusks. Location of carbon-14 samples is indicated by green "C". Scale bar is in cm.

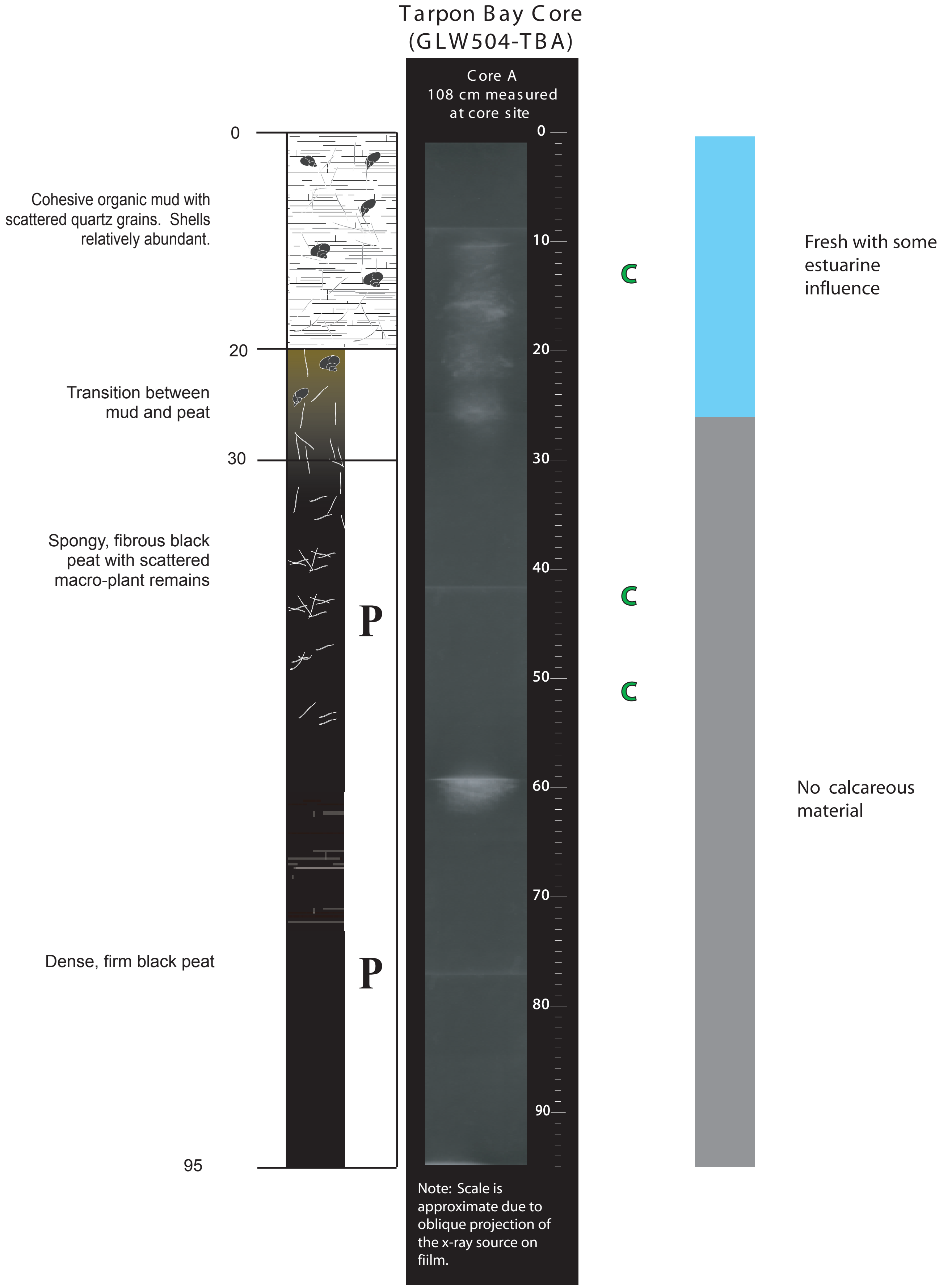


Figure 6. X-radiograph of Tarpon Bay core (GLW504-TBA), with schematic diagram and brief sediment description on the left, and a summary of the environments indicated from an examination of molluscan fauna on the right. Note, "no calcareous material" means no visible grains; closer examination of samples may find additional material, especially microfaunal remains. Location of carbon-14 samples is indicated by green "C". Scale bar is in cm.

20-30	Peaty mud, transitional zone between overlying mud and underlying peat, with plant material increasing downward and shell content and calcareous grains decreasing downward. (Black to brownish black - 5YR 2/1)
30-95	Peat, spongy, fibrous, black, with scattered macro-plant remains (leaves and wood). No visible quartz or calcareous grains. Density/compaction increasing downward.

Roberts River Core (GLW504-RRA) (Figure 7)

Depth (cm)	Description
0-18	Sandy mud, sediments liquefied in upper few centimeters, becoming more cohesive below; poorly sorted, ranging from very fine sand to mud, with a high organic component. Plant debris, wood fragments, and small shell fragments visible. (Dusky yellowish brown – 10YR 2/2)
18-28	Sandy mud, sediments more cohesive and moderately sorted; still ranging from very fine sand to mud, but matrix is mostly mud with only scattered larger grains. Scattered plant debris and small shell fragments visible. (Dusky yellowish brown – 10YR 2/2)
28-32	Sandy to shelly mud, transitional zone. Sediments are mottled. Overlying (18-28 cm) very fine sand to mud (10YR 2/2) forms matrix, but mottled with areas of clay (very pale orange - 10YR 8/2). Shell debris more abundant than overlying segments. Scattered very fine quartz grains present.
32-44	Shelly mud, sediments poorly sorted, ranging from abundant large pieces of shells to a mud matrix with very high water content; mottled (10YR 8/2 and 10YR 2/2). Moving downward through segment, visible shell content decreases slightly and area of light colored clay increases relative to the darker more poorly sorted material.
44-68	Clay, sediment is predominantly clay (pale yellowish brown 10YR 6/2). Finely disseminated fibrous plant material exists throughout, with scattered pieces of wood and occasional shell material. In lowest portion of segment (62-68 cm) matrix becomes slightly darker grading from pale yellowish brown (10YR 6/2) to dark yellowish brown (10YR 4/2).
68-80	Sandy mud, matrix contains very fine sand to silt size grains, with scattered shell material, including freshwater gastropods. (Dark yellowish brown – 10YR 4/2)
80-88	Clay, sediment is very cohesive, with visible wood fragments and fibrous plant material oriented vertically, probably in situ root hairs. (Pale yellowish brown – 10YR 6/2)

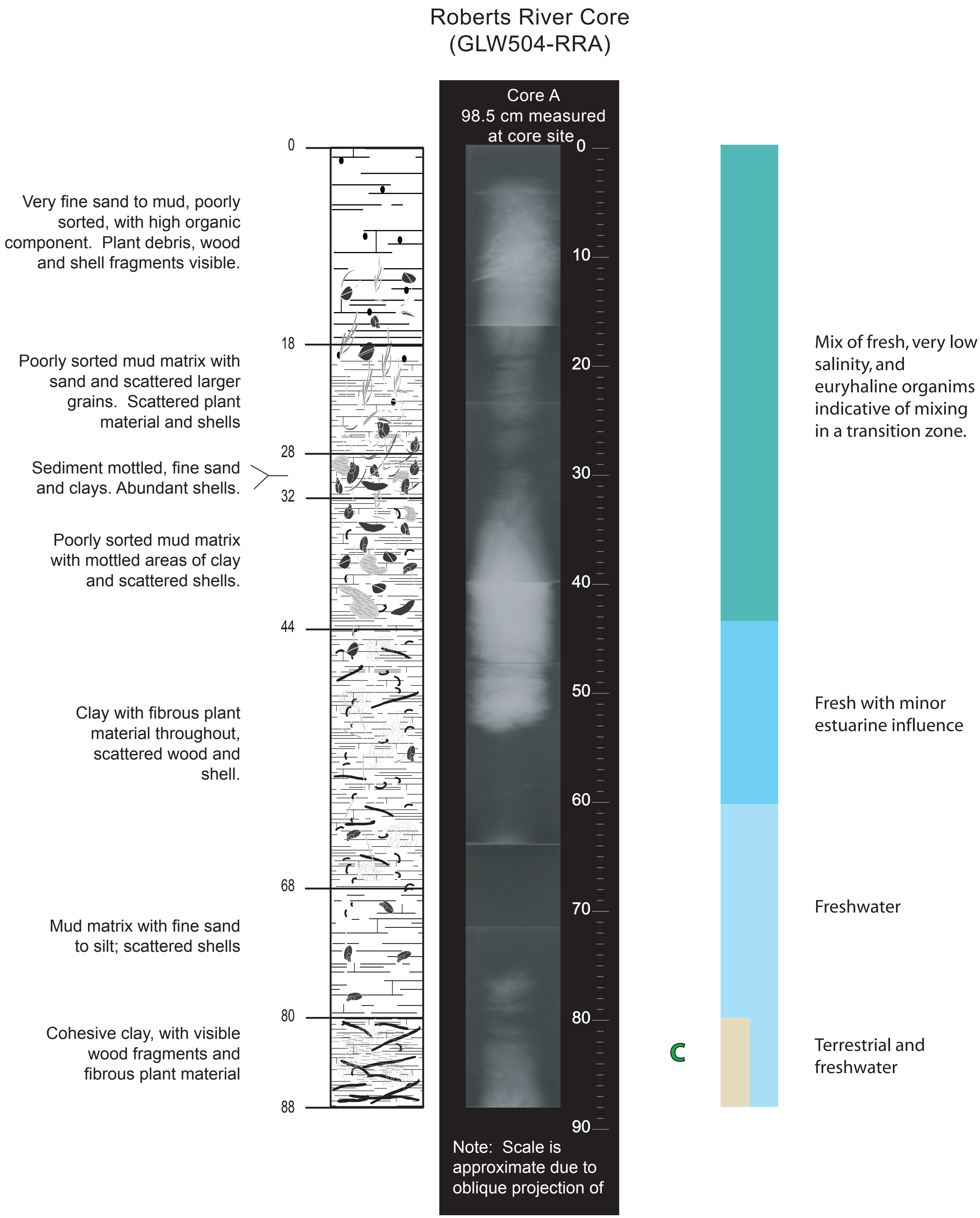


Figure 7. X-radiograph of Roberts River core (GLW504-RRA), with schematic diagram and brief sediment description on the left, and a summary of the environments indicated from an examination of molluscan fauna on the right. Ostracode and foraminfer paleoecologic data are in agreement with molluscan environmental indicators. (See text for discussion.) Location of carbon-14 samples is indicated by green "C". Scale bar is in cm.

DEPOSITIONAL ENVIRONMENTS

The preliminary analyses of the cores collected in 2004 from the southwest coastal area provide new information about the depositional and environmental history of the area. The four cores from the inner bays are strikingly different from any cores collected from the nearshore areas of Florida Bay or Biscayne Bay, and they appear to have captured a long record, extending back 1000 to 2000 years before the present (BP). In contrast, the core from the mouth of Roberts River (GLW504-RRA) is similar lithologically and faunally to cores examined from Florida Bay and Biscayne Bay, but the basal clays and woods also appear to be approximately 2000 years BP. The following discussion of the cores is arranged in a northwest to southeast transect.

Alligator Bay core (GLW504-ALA):
Alligator Bay core is predominantly a poorly sorted, clastic sand, containing minor amounts of plant material. Relatively worn shell material in the upper 8 cm indicate deposition in a primarily freshwater environment with some indications of estuarine influence (Figure 3; Table 3). No radiometric ages have been obtained on the core.

Big Lostmans Bay core (GLW504-LMA):
The core from Big Lostmans Bay is predominantly a peat (Figure 4). Carbon-14 ages indicate that the peats are relatively old; the sample at 20 cm is dated at 1060-1260 years BP and at 46 cm between 2350 and 2710 years BP (Table 4). Only the upper 10 cm of organic muds contains calcareous remains, and of these samples only the upper 6 cm contain recognizable remains but almost all molluscan remains exhibit signs of wear. The few mollusks present are indicative of a freshwater to oligohaline/mesohaline (<12 ppt) environment (Table 3).

Broad River Bay core (GLW504-BRA):
Broad River Bay core contains three distinct intervals (Figure 5). The lower portion of the core is a freshwater marl that contains abundant freshwater ostracodes and gastropods, well preserved charaphytes, and terrestrial gastropods (Table 3). This is overlain by a relatively thick zone of peat (62 cm). The top of the peat is approximately 2000 years old, based on carbon-14 analysis (Table 4). Overlying the peat is a zone of fine sand to clay with a high organic content, rare shell material, and charaphytes. Agglutinated foraminfers are present from 36-44 cm and above 14 cm. Carbon-14 analysis of a sample from 24 cm gives an age ranging from 0 (modern carbon) to 300 years BP. The upper 10 cm contains rare brackish ostracodes and scattered worn shell material. The few recognizable shells in the upper 4 cm are freshwater gastropods and *Cyrenoida*, an oligohaline to mesohaline clam. Overall abundance and diversity are very low.

Tarpon Bay core (GLW504-TBA:
The lower portion of Tarpon Bay core is peat (Figure 6). Carbon-14 analyses from samples collected from the peat at 50 cm and 42 cm give ages of 1070-1280 years BP and 1290-1410 years BP (Table 4). Freshwater gastropods and low salinity (<12 ppt) species

first appear at 24 cm in the transition zone between the peat and the overlying organic mud (Table 3). A sample of wood from 12 cm was analyzed for carbon-14, and returned an age ranging from 0 (modern carbon) to 430 years BP. The upper 20 cm contain a mixture of freshwater gastropods, *Cyrenoida, Polymesoda,* and mesohaline and euryhaline indicators. The presence of the tellinids and ostreids in the upper 10 cm of the cores indicate increasing estuarine influence in the youngest sediments of the core.

Roberts River core (GLW504-RRA):
The Roberts River core is from the mouth of the river where it empties into Whitewater Bay. This core differs from the other cores described in this study in the absence of peat (Figure 7), and the abundance and diversity of mollusks and calcareous microfossils throughout most of the core. There are similarities, however, to a core from Oyster Bay, on the western end of Whitewater Bay (Zarikian and others, 2001 and Nelson and others, 2002) and a core from Coot Bay, southeast of Roberts River (Nelson and others, 2002). The lowest portion of the core (88-80 cm) contains abundant wood material, and the mollusks present are predominantly freshwater with a few terrestrial species present (Table 3). A carbon-14 sample from 82 cm indicates the bottom of the core was deposited approximately 2000 years BP (Table 4). The overlying muds and clays from 80-60 cm contain freshwater gastropods, rare ostracodes and foraminifers (52-58 cm), chalky charaphytes, and scattered wood and plant material and from 60-44 cm a minor estuarine influence is indicated by the presence of *Cyrenoida*. The poorly sorted muds and sands above 44 cm contain mollusks indicative of transitional zones in estuaries, with a mix of freshwater, oligohaline, mesohaline, and euryhaline species. Charophytes in this upper segment are poorly preserved. The segment between 42 and 30 cm contains a foraminiferal assemblage dominated by *Ammonia*, with some *Elphidium* (genera common in freshwater/estuarine mixing zones); and an ostracode assemblage dominated by freshwater genera and the euryhaline *Cyprideis*, with occasional *Cytherura*. In the upper 30 cm, ostracodes and foraminfers are extremely abundant and well-preserved. The upper 30 cm contain abundant benthic foraminifers (*Elphidium, Ammonia, Miliammina,* and others) and ostracodes (mainly *Cyprideis*, *Perissocytheridea*, *Reticulocythereis*, *Malzella*, *Peratocytheridea*, *Cytherura*), with mesohaline species increasing in abundance upcore and non-marine species decreasing.

The overall picture that emerges from the preliminary examination of these five cores is that the southwest area has undergone distinctive changes over time (Figure 8). Big Lostmans Bay, Broad River Bay, and Tarpon Bay all show distinct changes in depositional environments over a millennial time-scale. Peats in these cores were deposited at least 1000 years BP based on the carbon-14 analyses and the peats are overlain by poorly sorted organic muds and sands containing species indicative of deposition in a freshwater to very low salinity environment. The Roberts River core shows a clear shift from a more terrestrially dominated freshwater environment at the bottom of the core (~ 2000 years BP) to an estuarine environment with a strong freshwater influence at the top of the core. These changes probably reflect a combination of sea-level rise and changes in freshwater supply, but the timing and extent of the changes needs to be determined.

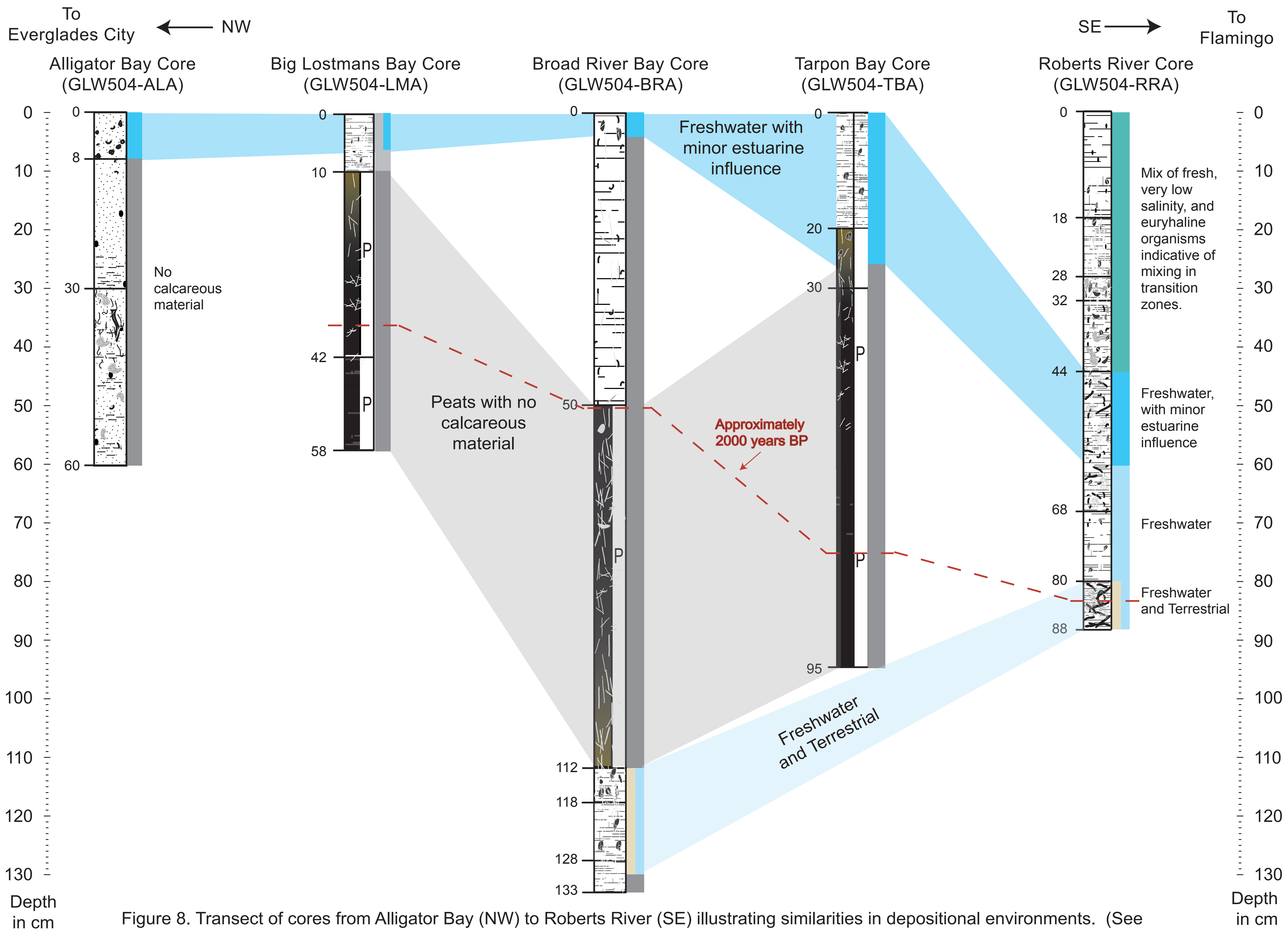


Figure 8. Transect of cores from Alligator Bay (NW) to Roberts River (SE) illustrating similarities in depositional environments. (See Figure 1 for location of cores). Scale shows depth in cm. Dashed red line is the approximate location of 2000 years BP in the cores based on the existing carbon-14 dates (see Table 4) for Roberts River and Broad River Bay cores and on sedimentation rates for the peats calculated from the carbon-14 dates for Big Lostmans Bay and Tarpon Bay cores.

SUMMARY

Preliminary examination of the five cores collected in May 2004 indicates that they cover a significant period of time –1000 to 2000 years or more – and will provide important insight into the linkage between the southwestern coastal environments and the terrestrial wetlands of the Everglades and Big Cypress areas. Due to the slow sedimentation rates indicated for the four inner-bay cores, it may not be possible to extract a decadal-scale temporal record of recent ecosystem history due to the time-averaged nature of the data; however, these cores will provide valuable insight into pre-anthropogenic conditions. The results from these 2004 cores will be linked with cores collected downstream in July 2005, to provide transects from the inner bays out to the marine ecosystem, thus providing a more complete picture of the geographic and temporal changes to the system. These transects will allow us to examine long term trends in freshwater supply, sea-level rise, and potentially the impact of storms on the coastal ecosystem.

The next steps in the study are to 1) complete the pollen analyses for the cores in order to examine regional scale trends in vegetation and correlate the inner-bay cores to terrestrial events previously documented (for eg., Willard and others, 2001: Riegel, 1965); 2) conduct lead-210 analyses on the upper portions of the cores to determine how much of the 20th century record is present in these cores; 3) calculate relative abundances of benthic fauna in upper portions of the cores for comparison to other cores in the region; 4) complete geochemical studies (C,N,P,S) of these cores. Additional carbon-14 analyses also will be done on samples near distinct changes detected in the fauna and flora to determine the timing of these events.

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